Studies on connections between soils, vegetation, management and erosion in human influenced grasslands of the northern Hungarian mountain range

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1. Abstract

Hungarian natural grasslands are usually managed by mowing or grazing. Cover of grasslands in Hungary exceeds 11% of the total area, about 20% of this being under nature protection. Grasslands generated by traditional landscape management were observed in two areas of the Northern Hungarian Mountain Range, concerning their soil base, botanical values, vegetation and its role in avoiding erosion. Laboratory analyses of nutrients gave opportunity for comparing soil relations and erosion of natural, ploughed, mowed or grazed areas. Many of the researched abandoned areas are in different stages of revegetation, resulting in the development of secondary grassland (slope steppe) in a close-to-natural state. Regular mowing resulted in high number of plant species. Lack of regular mowing on a parcel with similar management history, however, resulted in the dominance of aggressive weeds. Intensively grazed patches of grasslands in the Bükk Mts. (Nagymező area) developed after deforestation are characterised by high phosphorous and potassium content (P_2O_5: 275.5 mg/kg, K_2O: 427.5 mg/kg), especially around the stable of the Lipizza stud. Besides accumulation of nutrients, soils have become shallow and compacted caused by intensive trampling, giving a good indicator of overgrazing.

2. Introduction

Soil is a non-ewnewable natural resource (Várallyay 2007). Adequate cultivation is important for preserving soil quality and preventing the land from erosion (Centeri 2002a) as soil is one of the most important components of the landscape. Eroded soil carries important soil nutrients that is lost due to thes erosion processes (Centeri 2002b). Soil erosion models and soil erosion risk assessments are used for land evaluation all over the world (Evelpidou 2006, Gournellos *et al.* 2004, Barczi *et al.* 1997, Pottyondy *et al.* 2007, Kertész and Centeri 2006, Bádonyi 2006, Jakab and Szalai 2005, Várallyay 2007). In the present study examples of different land use forms, concentrating mainly on meadow/pasture areas are shown in order to prove degradation of two chosen areas from the Northern Mountain range of Hungary (Vojtkó & Marschall 1991, Vojtkó 2002).

3. Materials and methods

The amounts of AL-P_2O_5, AL-K_2O, soil organic matter (SOM), pH (KCl and H_2O), $CaCO_3$ and soil organic matter content were measured. Laboratory experiments were done according to the regulations at the Szent István University, Department of Nature Conservation and Landscape Ecology.

Different slopes sections were chosen for investigation in the Putnok Hill area. Soils were examined in situ by full soil profile descriptions (depth of layers, pH, color, soil physical type, carbonate content, soil types were determined) and by core sampling.

Coenological experiments and classification of N-demand and degradation

Coenological relevees were examined in 5 by 5 meter quadrates in the Putnok Hills and in the Bükk Mountains , too (Penksza et al. 2005). Cover (%) of plant species were given according to Braun-Blanquet (1964) method.

The Bükk area was described by the Borhidi relative ecological index (Borhidi 1995). We used the nitrogen demand values of the Borhidi indexes. Vegetation was examined in the summer periods of 1994, 2004 and 2005. Species names follow the nomenclature of Simon (2000). Degradation of the area was calculated by the method of Papp (1991).

In the Bükk Mts. pedological studies were prepared on pastures of the Nagymező area, Bükk Mts. (NE Hungary). Examinations sites were designated as moving further from the summer stable of the Lipica stud, on the sample sites of the coenological examinations made in 1994, 2004 and 2005. Based on the pedological examinations, original, typical soil type of the area was Luvisol. The area has originally been covered by forest.

In the Putnok Hills slopes pares with different vegetation cover were chosen for investigation. In the Alsószuha area three different parallel vegetation cover stripes were examined (slope angle 12-17% on the lower slope and in the category of 17-25% in the upper slope third) in Alsószuha. In Gömörszőlős the upper slope belonged to the category of 12-17%, the lower slope in the category of 5-12%.

4. Results

Putnok Hills

A slope pair of arable and grassland was compared in the Gömörszőlős region. As shown in Table 1, there are differences in the soil nutrient characteristics between the upper and lower slope thirds. The Gömörszőlős area can be described with extensive land use but this specific area is used intensively.

Table 1 Laboratory data of topsoil in Gömörszőlős, Hungary

Surface cover	Slope	$CaCO_3$	AL-P_2O_5	AL-K_2O	SOM***
		(%)	(mg*kg^{-1})	(mg*kg^{-1})	(%)
Arable land	UST*	21,3	140,84	463,99	2,33
	LST**	7,8	166,36	558,55	3,16
Grassland	UST*	19,3	110,14	483	3,91
	LST**	9,7	181,6	532,2	4,45

*UST=Upper Slope Third, **LST=Lower Slope Third, ***SOM=Soil Organic Matter

The difference between the slope thirds is more significant on the arable lands of the Alsószuha region (Table 2.) while abandoned, re-vegetated land shows much smaller differences in the distribution of the soil nutrients over the slope.

Table 2 Laboratory data of topsoil in Alsószuha, Hungary

Surface cover	Slope	$CaCO_3$	AL-P_2O_5	AL-K_2O	SOM***
		(%)	(mg*kg^{-1})	(mg*kg^{-1})	(%)
Arable land	UST*	0	32,41	162,68	2,55
	LST**	0	90,07	184,35	3,28
Abandoned for 10 years	UST*	0	28,67	141,86	3,01
	LST**	0	20,85	118,72	2,37
Abandoned for 40 years	UST*	0	66,59	166,23	2,5
	LST**	0	19,58	188,04	2,86

*UST=Upper Slope Third, **LST=Lower Slope Third, ***SOM=Soil Organic Matter

Bükk Mts.

Intensively grazed patches of grasslands in the Bükk Mts. (Nagymező area) developed after deforestation are characterised by high phosphorous and potassium content (Table 3.), especially around the stable of the Lipizza stud.

Table 3 Results of soil laboratory experiments, Bükk Mts., Hungary

Soil parameters	Sample site codes							
	1/A	1/B	2/A	6/A	6/B	6/E	7/A	7/B
pH H_2O	6.6	6.7	6.5	5.9	5.8	5.4	5.3	6.2
pH KCl	6.0	6.2	6.0	5.0	4.1	4.3	4.7	5.2
SOM %	17.9	4.7	13.7	11.6	2.1	3.2	16.2	2.0
P_2O_5	321.2	14.8	229.8	13.6	10.9	9.0	139.4	11.6
K_2O	537.2	143.4	317.8	297.8	79.4	51.3	288.0	69.7
N availability	very good				adequate	very good		adequate

Soil parameters	Sample site codes						
	7/E	8/A	9/A	9/B	9/E	10/A	11/A
pH H_2O	5.4	5.7	5.1	5.8	4.9	4.93	4.93
pH KCl	4.0	5.0	4.1	3.9	4.0	4.10	4.09
SOM (%)	4.3	21.1	16.5	9.2	6.5	12.3152	16.5645
P_2O_5	18.7	96.6	113.0	14.8	2.7	7.60	103.20
K_2O	54.3	280.7	222.1	89.6	86.2	256.75	242.69
N availability	very good						

A, B and E are soil horizons, numbers are identical with the number of coenological relevees

Areas 6-7. can be characterized by average nutrient content (Table 3.). Soil thickness is very heterogeneous, varies between 60-90cm. This soil thickness results good soil water regime. Area 8. can be characterized by good nutrient and high soil organic matter content (Table 3.). Soil thickness is 35cm. This soil thickness results bad soil water regime. Areas 9-10-11. are at the bottom of dolinas in the accumulation zone of the slopes. B horizons of the soils are greatly disturbed, reaching 100cm depth. These soils are colluviums of Luvisols. Area 11 is a little less disturbed because it is inside a fence. Degradation rate of the area can be seen in Table 4. The degradation rate of each relevees was calculated.

Table 4 State of degradation in the examined quadrates, Bükk Mts., Hungary

Quadrates	1	2	3	4	5	6	7	8	9	10	11
Rate of degradation	9,2	17,89	19,43	6,92	31,26	0,77	0,9	1,54	0,4	0,53	0,97

Overall degradation of the areas has increased significantly between 1994 and 2005. In 1994 the average degradation rate was 1.05 while in 2004 it increased to 1.8 and further increase (2.3) was calculated in 2005 (Table 4.). High degradation rates belong to the sample area of the summer stud.

Distribution of the relative nitrogen demand can be seen in Table 5. The closer we are to the summer stud the greater the disturbance is base don the examination of the vegetation. Near the dolinas and the fenced areas can be charaterised as areas with less nitrogen demand. The examined three periods proved that species distribution is moving towards nitrophil species.

Table 5 Distribution (%) of the different relative N demand categories (ND 1-9.) in the examined quadrates by years (a: 1994, b: 2004, c: 2005), Bükk Mts., Hungary

ND	1/a	1/b	1/c	2/a	2/b	2/c	3/a	3/b	3/c	4/a	4/b	4/c
2	7.8	0	4.88	4.4	3	2.11	6.4	0	4.85	14.2	9.8	2.68
3	0	0	0	11	0	0	9.6	0	0	15.6	1.9	0
4	7.8	0	3.66	24.2	4.6	0	19.3	1.3	1.94	32.5	1.9	3.57
5	24	55.3	24.39	23	33.3	8.42	17.9	32.8	9.71	13.6	13.6	12.50
6	7.8	20.3	12.20	8.8	16.6	27.37	29	39.5	20.39	15.6	31.3	32.14
7	52.5	24.2	40.24	28.6	41.5	58.95	17.6	26	60.19	7.8	41.1	47.32
8	0	0	14.63	0	0	3.16	0	0	2.91	0	0	1.79
ND	**5/a**	**5/b**	**5/c**	**6/a**	**6/b**	**6/c**	**7/a**	**7/b**	**7/c**	**8/a**	**8/b**	**8/c**
1	8.6	0	0	15.1	8	3.21	2.6	1	6.45	3.9	0	2.17
2	20.1	6.5	5.10	22.5	14.4	16.03	28.5	36.3	25.81	32.4	28	19.57
3	43.4	0	0	39	8	19.87	26	3	14.84	35.2	21.5	32.61
4	16.1	3.9	3.06	3.7	32	32.05	14.3	45.5	30.97	7.9	21.3	13.04
5	5.8	34.1	10.20	7.5	20.8	15.38	19.6	2	13.55	8	15.1	10.87
6	7.5	19.7	23.47	3.7	0	3.85	6.5	3.2	5.16	5.3	10.8	8.70
7	0	35.4	54.08	3.8	3.2	9.62	0	5.3	3.23	5.5	10.8	13.04
8	0	0	2.04	0	0	0	0	0	0	0	0	0
9	0	0	2.04	0	0	0	0	0	0	0	0	0
ND	**9/a**	**9/b**	**9/c**	**10/a**	**10/b**	**10/c**	**11/a**	**11/b**	**11/c**			
1	10.2	4.3	4.73	1.2	2.2	2.16	4.9	0	0			
2	25.8	44	27.81	27.6	28.2	21.58	25.5	10.4	20.90			
3	21.8	15.4	18.34	21.6	15.1	18.71	29.6	36.7	22.39			
4	16.8	31	26.04	20.4	43.8	33.09	18.3	15.7	35.82			
5	17.8	13.6	13.61	22.8	9.9	12.23	13.3	37	17.91			
6	7.6	0.8	4.14	6	4.4	9.35	7.3	0	0			
7	0	6	5.33	0	2.1	2.88	0	0	2.99			

Classification of the area proved that relevees near the summer stud was significantly different from the other areas in 1994. In 2004 50-150m far from the summer stud relevees are different from those of the summer stud but the difference is smaller.

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